

A HYPOTHESIS FOR A DIFFERENTIATED VERY SURFACE OF THE MOON BY
REGOLITH PROCESSES: Abhijit Basu, Department of Geology, Indiana
University, Bloomington, IN 47405.

INTRODUCTION. The remote sensing methods with which we map other planetary bodies provide us with the composition and mineralogy of the top few mm of the planetary surface, i.e., the very surface. From these data, inferences regarding the crustal compositions of planetary bodies are commonly drawn. Lunar samples have provided opportunities for refinement and calibration of remote sensing methods, especially for infrared spectroscopy and X-ray fluorescence. Lunar samples, however, are not necessarily obtained from the moon's very surface. Regolith samples are usually relatively deep scoops and rock samples are commonly much larger and are ejecta from below the very surface. Therefore, only if regolith processes have thoroughly mixed and homogenized the lunar regolith, the material at the very surface would not be different from that at other levels of the regolith.

HYPOTHESIS. We hypothesize that the small-scale process of micro-meteoritic bombardment can and has made the chemical and mineralogical composition of the very surface of the moon different from the rest of the regolith.

RATIONALE. It has been observed in nearly every drill core from the moon that the top few mm are enriched in agglutinates. If the chemical and mineralogical compositions of agglutinates are similar to those of the average lunar soils at the site, then our hypothesis is wrong. It has been shown that metallic Fe is much more abundant in agglutinates than in any other common particle in the lunar regolith. Ostensibly, metallic Fe is a reduction product of mafic silicates in the agglutination process. If so, the silicate phases of agglutinates should be more felsic than the soil from which the agglutinate had formed.

Microprobe analyses of agglutinitic glass in general suggest that single agglutination events are accompanied by total melting of the lunar soil target of a micrometeorite projectile. However, because the target is very small, about a cubic mm or smaller, unless the different size fractions of the lunar regolith have identical compositions, the composition of agglutinitic glass should be biased towards that of the fine-sized material in the regolith. Note that it is also easier to melt a porous target, e.g., a soil, than a solid target, e.g., a rock, via impact. It has been conclusively shown that the chemical and mineralogical composition of lunar soils are fundamentally dependent on grain size. It has also been shown that the composition of agglutinitic glass is biased towards the composition of the finest fraction of lunar soils. Therefore, if the process of incorporation or fusion of the finest fraction is dominant or not, is immaterial to our argument.

It has been shown indirectly that a preferential incorporation of the very fine fraction of lunar soils takes place in agglutinates. Thus, it is clear that the chemical and mineralogical compositions of agglutinates, i.e., the particles that are enriched at the very surface of the moon, are different from the rest of the regolith.

If one considers only the small impacts of micrometeorites, which probably eject particles $\leq 100 \mu\text{m}$ in size, another probable mechanism of regolith differentiation may be identified. At that size range lunar soil

particles are mostly agglutinates, monomineralic plagioclase or pyroxene, and glass of various compositions. The flight time of any ejected particle is dependent on its mass for any given ejection energy. If particles of the same size are considered, flight time is dependent on the apparent density of the particle. Thus, we expect a density differentiation by this postulated ballistic process. The felsic light particles, being in flight longer than the mafic heavier particles, should preferentially accumulate on top of the latter with continued micrometeoritic bombardment. Note that large impacts have diminished logarithmically through time whereas micrometeoritic impacts have become dominant. Therefore, the cumulative effect of a long process should be to concentrate feldspathic material at the very surface of the moon relative to mafic material.

STATUS. The degree of differentiation that may have taken place in the lunar regolith according to our hypothesis has not been worked out. The hypothesis itself remains to be evaluated in detail. However, it seems likely that the very surface of the moon may not be representative of the rest of its regolith and that some of the calibration of remote sensing methods, if dependent on regolith petrology, may have to be revised.